

**What is claimed is:**

1. A constant current source with threshold voltage and channel length modulation, comprising:

5 a first MOS transistor including a gate terminal, a first terminal and a second terminal;

a second MOS transistor including a gate terminal, a first terminal and a second terminal, wherein the second terminal is coupled to the first terminal of the first MOS transistor;

10 a third MOS transistor including a gate terminal, a first terminal and a second terminal, wherein the gate terminal and the first terminal are coupled to the gate terminal of the second MOS transistor;

15 a fourth MOS transistor including a gate terminal, a first terminal and a second terminal, wherein the gate terminal and the first terminal are coupled to the gate terminal of the first MOS transistor and the second terminal of the third MOS transistor, and the second terminal is coupled to a first reference voltage; and

a fifth MOS transistor acting as a resistor and electrically connected to the gate terminal and the first terminal of the third MOS transistor.

20 2. The constant current source with threshold voltage and channel length modulation of Claim 1, wherein the second terminal of the first MOS transistor is used for outputting current of the current source.

25 3. The constant current source with threshold voltage and channel length modulation of Claim 1, wherein the fifth MOS transistor has a gate terminal, a first terminal and a second terminal, and the gate terminal and the second terminal are respectively coupled to a second reference voltage and a third reference voltage.

4. The constant current source with threshold voltage and

channel length modulation of Claim 1, wherein the second MOS transistor is coupled to a voltage supply by way of a switch circuit.

5        5. The constant current source with threshold voltage and channel length modulation of Claim 4, wherein the switch circuit includes two MOS transistors whose second terminals are together coupled to the first terminal of the second MOS transistor and whose first terminals are together coupled to the voltage supply.

10       6. The constant current source with threshold voltage and channel length modulation of Claim 1, wherein the first, second, third and fourth MOS transistors are N-type MOS transistors, the fifth transistor is a P-type MOS transistor and the first and second terminals are drain and source electrodes, respectively.

15       7. The constant current source with threshold voltage and channel length modulation of Claim 1, wherein the output current of the constant current source is formulated as follows:

$$I_1 = K_1 \frac{W_1}{L_1} (V_{r1})^2 (1 + \lambda V_{DS1})$$

20       wherein  $K_1$  is a parameter of the first MOS transistor,  $W_1$  is the channel width of the first MOS transistor,  $L_1$  is the channel length of the first MOS transistor,  $V_{r1}$  is the first reference voltage,  $V_{DS1}$  is the relative voltage between the first and second terminals of the first MOS transistor and  $\lambda$  is a coefficient.

8. The constant current source with threshold voltage and channel length modulation of Claim 7, wherein the  $V_{DS1}$  satisfies the following formula:

25       
$$V_{DS1} = V_{th2}^2 - (2V_{GSb} - \frac{1}{k_b R_{on}})V_{th2} + V_{GSb}^2 - V_{OD2}$$

wherein  $V_{th2}$  is the threshold voltage of the second MOS transistor,  $V_{OD2}$  is the over-driving voltage of the second MOS transistor,  $K_b$  is a parameter of the third MOS transistor,  $V_{GSb}$  is the bias voltage between the gate terminal and second terminal of the third MOS transistor and  $R_{on}$  is the equivalent resistance of the fifth MOS transistor.

9. The constant current source with threshold voltage and channel length modulation of Claim 8, wherein the  $V_{th2}$  is substantially equal to  $V_{GSb} - \frac{1}{2k_b R_{on}}$ .

10. A constant current source with threshold voltage and channel length modulation, comprising:

a set of cascade transistors including a first MOS transistor and a second MOS transistor; and

a compensation circuit electrically connected to the first MOS transistor and the second MOS transistors so as to form a feedback circuit.

11. The constant current source with threshold voltage and channel length modulation of Claim 10, wherein the compensation circuit further comprises:

a third MOS transistor having a gate terminal coupled to the gate terminal of the second MOS transistor;

a fourth MOS transistor having a gate terminal, a first terminal and a second terminal, the fourth MOS transistor being in a series connection with the third MOS transistor, wherein the gate terminal is coupled to the gate terminal of the first MOS transistor and the second terminal is coupled to a first reference voltage; and

a resistor with constant resistance electrically connected to the third MOS transistor.

12. The constant current source with threshold voltage and channel length modulation of Claim 11, wherein the third and fourth MOS transistors act as diodes.

13. The constant current source with threshold voltage and channel length modulation of Claim 11, wherein the resistor with constant resistance is a fifth MOS transistor which has a gate terminal, a first terminal and a second terminal, and the gate and second terminals are separately connected to a second reference voltage and a third reference voltage.

14. The constant current source with threshold voltage and channel length modulation of Claim 10, wherein the set of cascade transistors is further coupled to a switch circuit.

15. The constant current source with threshold voltage and channel length modulation of Claim 11, wherein the output current of the constant current source is formulated as follows:

$$I_1 = K_1 \frac{W_1}{L_1} (V_{r1})^2 (1 + \lambda V_{DS1})$$

wherein  $K_1$  is a parameter of the first MOS transistor,  $W_1$  is the channel width of the first MOS transistor,  $L_1$  is the channel length of the first MOS transistor,  $V_{r1}$  is the first reference voltage;  $V_{DS1}$  is the relative voltage between the first terminal and the second terminal of the first MOS transistor and  $\lambda$  is a coefficient.

16. The constant current source with threshold voltage and channel length modulation of Claim 15, wherein the  $V_{DS1}$  satisfies the following formula:

$$V_{DS1} = V_{th2}^2 - (2V_{GSb} - \frac{1}{k_b R_{on}})V_{th2} + V_{GSb}^2 - V_{OD2}$$

wherein  $V_{th2}$  is the threshold voltage of the second MOS transistor,  $V_{OD2}$  is the over-driving voltage of the second MOS transistor,  $K_b$  is a parameter of the third MOS transistor,  $V_{GSb}$  is the bias voltage between the gate terminal and second terminal of the third MOS transistor and  $R_{on}$  is the equivalent resistance of the fifth MOS transistor.

17. The constant current source with threshold voltage and channel length modulation of Claim 16, wherein the  $V_{th2}$  is substantially equal to  $V_{GSb} - \frac{1}{2k_b R_{on}}$ .